(12) UK Patent Application (19) GB (11) 2 274 795 (13) A

(43) Date of A Publication 10.08.1994

(21) Application No 9302373.7

(22) Date of Filing 06.02.1993

(71) Applicant(s)
Keith John Kingham
Cartrefle, Talwrn, LLANGEFNI, Gwynedd, LL77 7SP, United Kingdom

(72) Inventor(s)
Keith John Kingham

(74) Agent and/or Address for Service
K Kingham Associates
Talwrn, Nr Llangefni, ANGLESEY, Gwynedd, LL77 7SP, United Kingdom

(51) INT CL[5]
B21C 23/24

(52) UK CL (Edition M)
B3A A122X
B3P PEAA P16C

(56) Documents Cited
GB 2266572 A GB 2266571 A GB 2266104 A
US 4520057 A US 4040162 A

(58) Field of Search
UK CL (Edition M) B3A , B3P , B5A
INT CL[5] B21C 23/00.
ONLINE DATABASES : WPI, CLAIMS

(54) Composite tube containing biocomposite material

(57) An in-line integrated system embodying continuous extrusion and drawing technologies in an integrated manufacturing process for the production of solid and hollow section non-ferrous metal clad biocomposite products. A process in which the biocomposite can be clad internally and/or externally with a seamless cladding of non-ferrous metal e.g. aluminium to produce value added structural composites from waste renewable and recyclable feedstocks.

GB 2 274 795 A

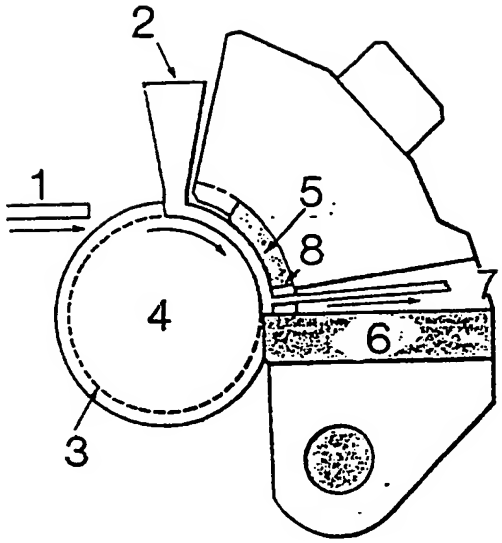

FIG 1

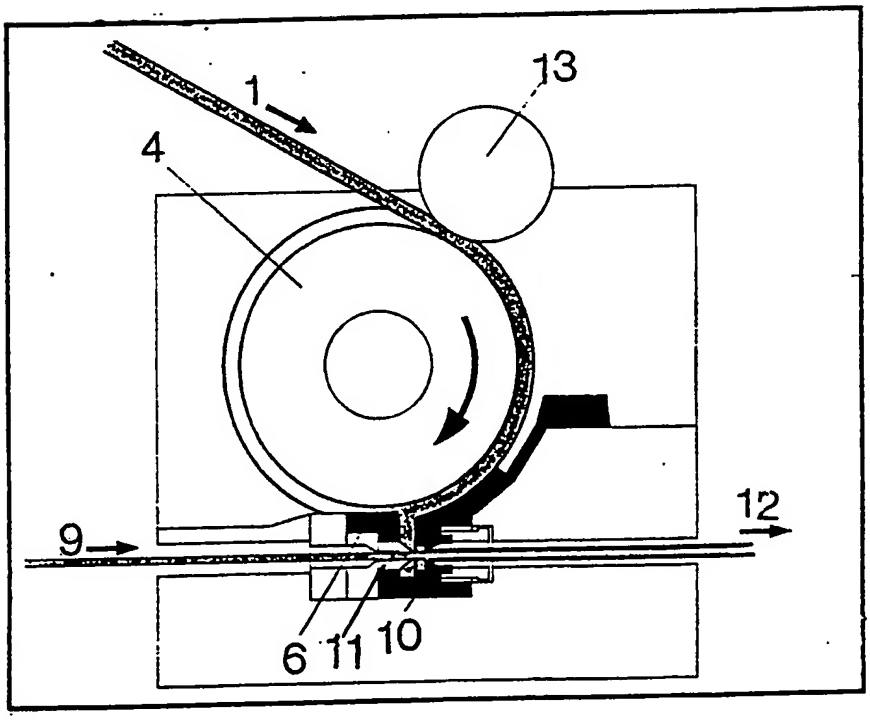

FIG 2

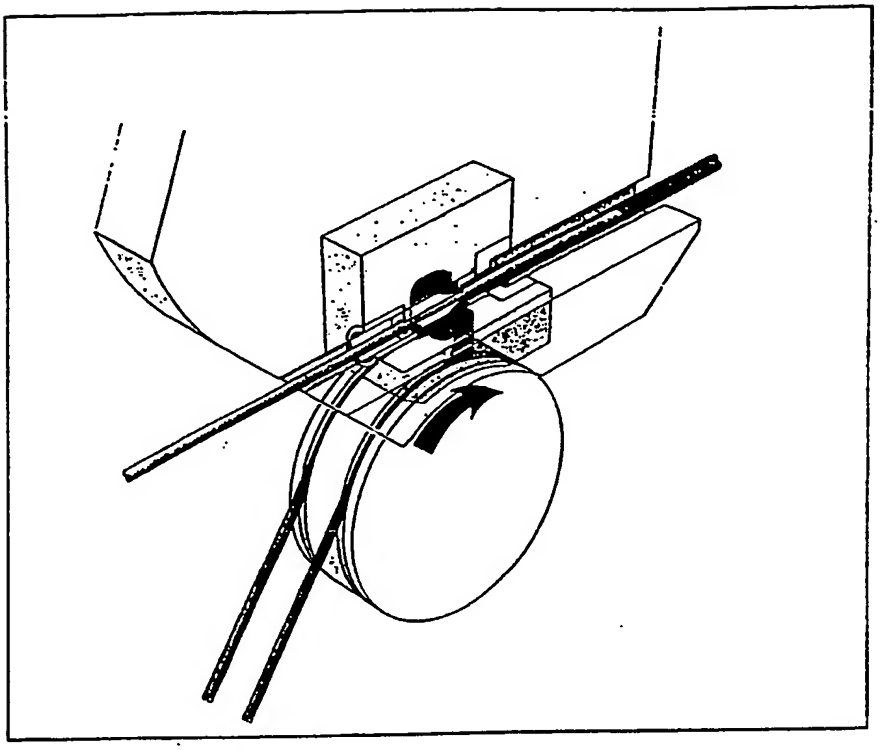

FIG 3

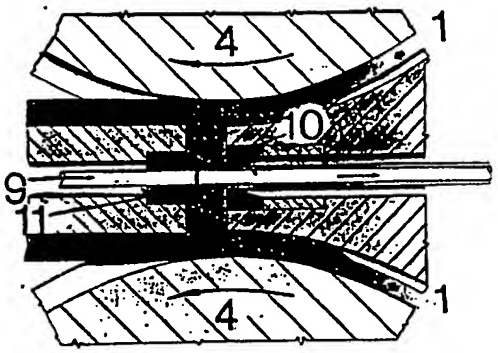

FIG 4

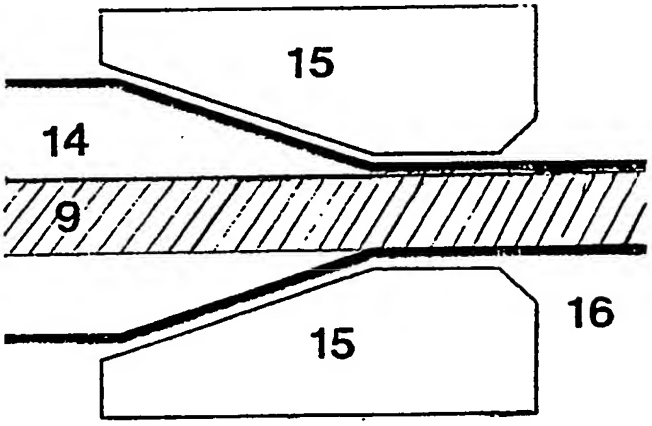

FIG 5

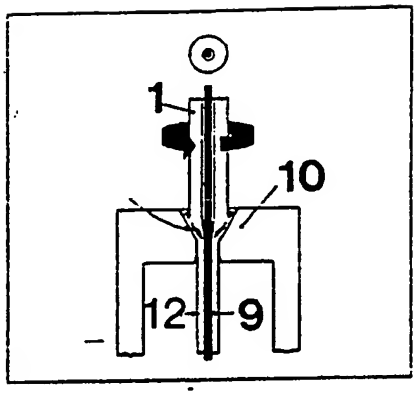

FIG 6

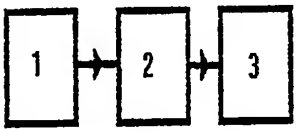

FIG 7

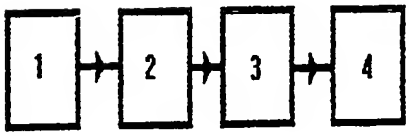

FIG 8

METHOD AND APPARATUS FOR PRODUCING NON-FERROUS METAL CLAD 2,3 AND 4-PART COMPOSITE PRODUCTS.

Background of the invention

This invention relates to the design of a volume manufacturing system to produce a range of new innovative aluminium or copper clad composite products. The products, themselves the subject of recently filed patents, reference applications 9208334.4,9208335.1 and 9208336.9 comprise bars, tubes and hollow sections, in which the inner core is made from a compressed and bonded waste, recycled or renewable material, of which wood and plant fibres are typical examples, clad externally in thin gauge aluminium or copper. In the case of hollow sections, the inner surface of the core may also be clad(lined) in similar thin gauge materials. The non-ferrous materials may in turn be recycled metal to produce high quality value added products made completely from recycled materials.

This innovative manufacturing process builds on two, recently developed, low capital, low operating cost, non-ferrous metal manufacturing processes, the "CONFORM" continuous extrusion process,operated in its cladding mode,as shown in Figures 2/4 & the "TECHNOFORM SONICS" ultrasonic drawing process, as shown in Fig 5.

The invention proposes the integration of these processes into an in-line manufacturing system for these products.in which the core may be pre-manufactured by other means, or by a specially adapted "CONFORM" unit and introduced in the conventional way for "CONFORM" cladding or may in turn be in-line manufactured as part of the integrated manufacturing facility.

A further variation envisages the integration of the even newer innovative "FRICTION CO-EXTRUSION" cladding process under development by TWI with the "TECHNOFORM SONICS" ultrasonic drawing process.

Specific embodiments of the invention will now be described by way of examples, with reference to the accompanying drawings,

Figure 1 shows a schematic of the CONFORM process operating in radial discharge mode,ie the generic process, which is to be adapted for manufacture of these aluminium clad composites. Non-ferrous metal feedstock, either solid rod (1) or particulate (2) is fed into the groove (3) of the extrusion wheel (4) and is drawn into the wheel under the grip segment (5), where it is carried through to a solid abutment (6) and is then softened by frictional heat and discharged radially as an extruded product (7) through a die (8).

Figure 2 shows in section, a single wheel CONFORM machine

operating in tangential discharge mode, the mode proposed for this integrated manufacturing process. This illustrates how cores (9)[steel in this example] can be introduced through a hollow die (10) and a hollow mandrel (11) to permit the production of clad wire product (12). In this example, the feedstock (1) for cladding is aluminium and a coining roller(13) is introduced.

Figure 3 shows in perspective sectioned view, a double grooved single wheel CONFORM machine in tangential discharge mode, arranged for producing clad wire products.

Figure 4 shows a sectioned detail of a twin wheel CONFORM machine producing an aluminium clad product, in which the core is again passed through a hollow mandrel. In this illustration, feedstock (1)[solid rods in this case] are fed into the grooves of the extrusion wheels (4). This illustrates in greater detail, the process previously described in figure 2 but using a twin wheel (4) single groove machine[instead of the twin groove single wheel machine previously described], in which each wheel is is fed with a solid non-ferrous rod feedstock (1). The core (9) is fed through the hollow mandrel (11) and hollow die (10). The cladding feedstock(1) is extruded around the mandrel (11) and through the die (10) to produce oversized cladding (14) ready for cool down prior to final draw down on to the core (9) to produce the pre-stressed composite product.

Figure 5 shows a diagram illustrating how the partially formed composite comprising core (9), with an oversized cladding (14) at this stage, is passed through an ultrasonically vibrated die or other proprietary draw down device (15) to achieve a final reduction in section to a size sufficient to impart optimum pre-compression to the core and produce the finished composite (16).

Figure 6 shows a schematic of the generic form of the friction co-extrusion cladding process being used to apply a non-ferrous metal cladding to a ferrous core material. In this case, the ferrous core (9) is introduced through a non-ferrous metal hollow section bar (1), which is being used as a rotating consumable to extrude a section through die (10). The non-ferrous cladding material is extruded at a different rate to the ferrous metal core to assist in the rupturing of the oxide films and facilitate metallurgical bonding to produce a clad product (12).

In the proposed adaption of the co-extrusion process for cladding the heat sensitive cores of these new composite products, it is proposed to incorporate a hollow mandrel and hollow die into the fixed die arrangement shown in figure 6. The cladding will then be extruded oversize, as with the proposed CONFORM adaption described in figures 2 and 4 and cooled prior to final drawdown to a finished product.

Figure 7 shows in block form, an in-line combination of the previously mentioned machines, items 1,2 and 3, which together, provide an integrated manufacturing facility for producing the aforementioned composite products. The three items comprise:-

1 A CONFORM machine adapted to produce the composite core, or an alternative core making device.

2 A CONFORM machine configured in tangential mode and for the production of oversize cladding to ensure clearance between core and cladding while the cladding remains hot. An appropriate cooling device to reduce the cladding to the required core temperature before draw down.

3 A TECHNOFORM SONICS ultrasonics or alternative draw down device to draw down the oversize tube to an optimum size below the core diameter.

In the CONFORM cladding mode, the outercladding will be extruded oversize to prevent contact with the heat sensitive core and cooled before final draw down onto the core, the preferred drawing process being the ultrasonic TECHNOFORM process which provides a good surface finish. A key requirement of the drawdown process is to provide controlled reduction of the composite product & sufficient densification of the core to maintain good contact pressure between core & cladding to compensate for limited volume changes caused by temperature & humidity changes. Multiple passes may be required. The circumferential stresses induced in the cladding and the increased densification of the core are also key processing requirements to improve the impact resistance of the thin cladding materials.

It is also envisaged that this compressive drawdown will be conducive to ensuring optimum bonding between cladding and core, if an intermediate adhesive is found beneficial.

Referring to Figure 7, an alternative arrangement of the integrated manufacturing system is envisaged, in which the CONFORM machine is replaced by a FRICTION CO-EXTRUSION machine.

Hollow section internally and externally clad products including composite tubes, will be produced in a similar integrated manufacturing facility,in which the four items of Figure 8 comprise:-

1 A CONFORM machine configured in tangential mode for the production of an aluminium tube(the inner cladding of the final hollow section composite product).

2 A CONFORM machine configured in tangential discharge mode for extruding a non-metallic cladding around the previously formed aluminum tube to form an intermediate hollow section two-part composite for use as a core for the next stage. Alternatively a wrapping or winding machine may be used for laying up a non-metallic fibre or thread as a cladding to produce the intermediate hollow section 2-part composite for use as a core in the next stage.

3 A CONFORM machine configured in tangential cladding mode and fed with a central composite core made in the previous stage and set up for the production of oversize cladding to ensure clearance between core and cladding while the cladding remains hot. Equipped with an appropriate cooling device to reduce the cladding to the required non-metallic core temperature before final draw down.

4 A TECHNOFORM SONICS ultrasonics or alternative proprietary draw down device to draw down the oversize tube to an optimum size below the core diameter.

Referring to Figure 8, an alternative arrangement of the integrated system for manufacturing hollow section internally and externally clad composites is envisaged, in which, the CONFORM machine is replaced by a friction co-extrusion machine.

It is envisaged that it may be necessary to carry out some final draw down passes simultaneously with draw up/expansion passes to obtain optimum finished product core and cladding pressures.

CLAIMS

1 An integrated in-line manufacturing process for the production of the new range of 2, 3 and 4-part aluminum clad composite products (as specified above), in which the core is made from biocomposite or waste materials

2 A process as claimed in claim 1, in which the preferred feedstock materials are aluminium and wood or plant fibres.

3 A process as claimed in claim 1, in which the production of the core is carried out by a specially adapted CONFORM machine.

4 A process as claimed in claim 1, in which the cladding is carried out by a specially adapted CONFORM machine.

5 A process as claimed in claim 1 in which the cladding is carried out by a specially adapted FRICTION CO-EXTRUSION machine with an in-built cooling system to cool the cladding to optimum core temperature prior to final draw-down.

6 A process as claimed in claims 1 and 2, in which the cladding is drawn down to finished size and optimum pressure applied to the core by the TECHNOFORM ultrasonics or alternative proprietary draw-down device.

7 A process in which hollow section internally and externally aluminium clad products are produced by the production of an intermediate product core comprising a non-metallic core as a cladding to the pre-extruded inner aluminium cladding

8 A process as described in claims 4 and 5, in which the intermediate hollow core of claim 7 is used as the core feedstock, to produce hollow section composites clad internally and externally in aluminium

Amendments to the claims have been filed as follows

1 An integrated in-line manufacturing process for the production of the new range of 2, 3 and 4-part non-ferrous metal clad composite products (as specified previously).in which the core is made from biocomposites.

2 A process as claimed in claim 1. in which the preferred feedstock materials are aluminium and wood or plant fibres.

3 A process as claimed in claim 1. in which the production of the core is carried out by a specially adapted CONFORM machine.

4 A process as claimed in claim 1. in which the cladding is carried out by a specially adapted CONFORM machine.

5 A process as claimed in claim 1. which applies a seamless cladding around the biocomposite core

6 A process as claimed in claim 1 in which the cladding is carried out by a specially adapted FRICTION CO-EXTRUSION machine with an in-built cooling system to cool the cladding to optimum core temperature prior to final draw-down.

7 A process as claimed in claim 1, in which the cladding is drawn down to finished size and optimum pressure applied to the core by the TECHNOFORM ultrasonics or alternative proprietary draw-down device.

8 A process as claimed in claim 1, for producing an intermediate product core comprising a biocomposite lining as an external cladding to a non-ferrous metal profile. the profile being produced by the CONFORM or other extrusion process.

9 A process as claimed in claim 1, in which hollow section internally and externally, non-ferrous metal clad biocomposite products are produced by the introduction of an intermediate product core produced as claimed in claim 8.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9302373.7
Relevant Technical Fields (i) UK Cl (Ed.M) B3A, B3P, B5A (ii) Int Cl (Ed.5) B21C 23/00	Search Examiner A R MARTIN Date of completion of Search 18 FEBRUARY 1994
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE DATABASE: WPI, CLAIMS	Documents considered relevant following a search in respect of Claims :- All claims

Categories of documents

X:	Document indicating lack of novelty or of inventive step.	P:	Document published on or after the declared priority date but before the filing date of the present application.
Y:	Document indicating lack of inventive step if combined with one or more other documents of the same category.	E:	Patent document published on or after, but with priority date earlier than, the filing date of the present application.
A:	Document indicating technological background and/or state of the art.	&:	Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X,E	GB 2266571	(KINGHAM) see page 4	Claims 1 & 7 at least
X,E	GB 2266572	(KINGHAM) see page 2 paragraph 4	Claims 1 & 7 at least
X,Y	US 4040162	(ISOGAI) see example 1	Claims 1 & 7 at least
Y	US 4520057	(KAWASAKI) see column 5 lines 40-55	Claims 1 & 7 at least
X,E	GB 2266104	(KINGHAM) see page 3 paragraph 2	Claims 1 & 7 at least

Databases:The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).